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BULLETIN

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TORREY BOTANICAL CLUB

OCTOBER, 1911

The ferns and flowering plants of Nantucket—VIII

EUGENE P. BICKNELL

ROSACEAE (continued)

SPIRAEA LATIFOLIA (Ait.) Borkh.

Uncommon; a few small plants between Siasconset and Saul's Hills (1899) and west of Sankaty (1906); a considerable growth at Rotten Pumpkin Pond, in full flower, Aug. 11, 1906.

SPIRAEA TOMENTOSA L.

Scarce, but widely scattered; often undersized. Below the "Cliff"; Maxcy's Pond; the Woods; Polpis; Quaise.

FRAGARIA VIRGINIANA Duchesne.

Common in fields, thickets, and grassy places generally, sometimes in pure sand. First ripe fruit June 10, 1911, but some plants still in blossom June 15.

FRAGARIA VESCA L.

Well established in the thorn lot, growing with *Fragaria virginiana* in the grass along the fences. Green fruit and some remaining flowers June 19, 1910. Rather a small form of the species, the fruit hemispheric to subglobose.

ARGENTINA ANSERINA (L.) Rydb.

Found at one spot only, on the western side of the island near the south shore, close to a small pond lying between Hummock Pond and the life-saving station. Here, on June 7, 1910, a shallow grassy depression in the sandy plain, some seven by eight paces in extent, was starred with its earliest flowers. Flowers commonly smaller than those of *Argentina litoralis*, spreading 2–2.8 cm.,

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in color more of a lemon yellow, the petals not emarginate; larger leaves 2.5 dm. long with leaflets over 5 cm.; young leaves silvery sericeous on the upper surface, becoming bright light green and glabrate; roots simpler, stouter, and more woody than in *A. litoralis*, often subtuberous thickened.

*ARGENTINA LITORALIS Rydb.

Local about the borders of salt marshes along the harbor from Quaise to Polpis, also by Sachacha Pond; common in a brackish or nearly fresh meadow at Shawkemo; not found on the south shore. In full flower June 2, 1909, June 7, 1908, June 20, 1910; some plants still in bloom Aug. 5, 1906. Flowers variable in size, the largest having a spread of 3–3.5 cm.; petals deeper yellow than those of the preceding species, emarginate; leaves bright green and glabrous on the upper surface. Occasionally in moist places where the soil has been enriched by deposits of eelgrass, the plant takes on an unusually strong growth, the leaves becoming over 3 dm. long, with leaflets over 5 cm.; in harder or drier soils it is often notably reduced in size.

POTENTILLA ARGENTEA L.

Common in sandy fields, especially in the town region, but extending across the island from Madequet to Quidnet. Just in flower May 31, 1909, June 3, 1911, June 15, 1910; late flowers at one locality Sept. 19, 1909.

POTENTILLA MONSPELIENSIS L.

Not common, but occurring in nearly all quarters of the island, usually, however, solitary plants or only a few together. Found in waste spots and near cultivated land, as well as in low grounds at remoter places, as at Pout Pond, Wigwam Pond, and Pocomo Head Pond. Not yet in flower June 7, 1909; freshly in bloom June 18, 1909; a single plant bearing flowers Sept. 21, 1907.

POTENTILLA CANADENSIS L.

Common in fields and thickets. Freshly in flower May 30, 1909, June 3, 1911.

POTENTILLA SIMPLEX Michx.

Frequent in damp thickets and low grounds; first flowers June 2, 1909, June 7, 1908.

*POTENTILLA PUMILA Poir.

Common in dry open places in poor or sandy soil. Among the Miacomet pines, where the trees grow thickly and the soil remains damp beneath their protecting shade, there grows a form of this species, I do not determine it to be any other, which departs widely in appearance from the typical plant. It is marked by very delicate structure throughout, slenderly filiform and flexuous stems and pedicels, and rather large bright green leaves, the thinly pubescent leaflets becoming broadly cuneate-obovate and saliently dentate or incised mostly above the middle. With it occurs a form of *Potentilla canadensis* somewhat similarly modified but in less notable degree.

GEUM CANADENSE Jacq.

Rather common in thickets on the eastern side of the island from Shawkemo to Squam. A few plants remaining in flower by the middle of August, 1906; a single belated blossom Sept. 17, 1907. No flower buds visible up to June 26, 1910.

Note.—It appears that through an error now impossible to account for, the name *Geum virginianum* L. somehow found its way into Mrs. Owen's catalogue. Mr. F. G. Floyd has recently written to Mrs. Owen in regard to the status of this species as a Nantucket plant and has kindly sent me her reply, in which she entirely repudiates that entry in her list and expresses the wish that it be corrected. Mrs. Owen writes that she has consulted the original notes and records on which her catalogue was based, which contain no reference whatever to the plant in question, "which she never found herself or had reported by any body else from Nantucket."

AGRIMONIA GRYPOSEPALA Wallr.

A. hirsuta (Muhl.) Bicknell.

Frequent in thickets throughout the same section of the island occupied by *Geum canadense*, and often growing with it.

Conformity with the practise of the day leads me to use for this species the name given by Wallroth, an appropriate name indeed, but nevertheless one junior by some thirty years to that bestowed by Muhlenberg, whose good botanical eye first saw a distinctively American plant in our species hitherto viewed as a plant of Europe. The priority of Muhlenberg, however rejected

by the rulings of the day and hour, may not, perhaps, for all botanical time be held in disregard. For it is not impossible to conceive that the course of nomenclatural reform in its ebb and flow may some day finally swing true to the line of organic morals, receiving for this plant, as for many another, the distinctive name by which it was first baptized into the annals of botany. In an early chapter of Genesis we find a primary if not now controlling law of nomenclature first laid down.

***Agrimonia Bicknellii** (Kearney) Rydb. comb. nov.

A. mollis var. *Bicknellii* Kearney.

Infrequent or rare; a few plants at the border of a thicket in Squam and at two stations in Quaise (1906), in full flower Aug. 13; Watt's Run bank June 15, 1908, a few plants not yet in bud.

ROSA CAROLINA L.

Common in swamps and low grounds.

ROSA VIRGINIANA Mill.

Abundant either in dry or moist soils, often massed in extensive growths and forming an entanglement of formidable character about the borders of low thickets and on banks passing down to pond holes or low grounds. First flowers June 17, 1908, June 17, 1910; not yet generally in flower June 23; a few flowers remaining Sept. 10, 1907.

*ROSA sp.?

I do not venture here to add a new name in a group of roses having already a too perplexed synonymy, and yet I would give express recognition to a rose closely allied to *Rosa virginiana*, which nevertheless seems to announce itself with some emphasis as being not the same. It is primarily distinguished by pyriform fruit, narrowed towards the base or decursive on the peduncle. In typical *Rosa virginiana* the broadly depressed globose fruit, expanded abruptly from the peduncle, contrasts notably with that of this Nantucket and Long Island rose, which is found growing with it, less often intermixed than in separate associated colonies. It remains to be determined whether forms appearing intermediate between the two represent natural transitions from one to the other or are a result of hybridization. It has not appeared that the marked differences in the fruit are attributable to the presence of a fungus or to insect agency.

As compared with *Rosa virginiana* typical examples of this associated rose differ in their more slender, straighter, and longer infrastipular spines and less numerous prickles; numerous often crowded leaves, smaller and narrower more membranous stipules and leaflets, the latter more narrowed to the base and finely serrate with very acute teeth, dark green and shining above, pale or lighter green beneath; flowers fewer and less clustered, commonly 1–3, not large, spreading about 5 cm., the petals deeply emarginate; fruit lighter red, more or less pyriform, or tapering into the peduncle, contracted or narrowed to a smaller orifice and with thicker walls; calyx lobes densely glandular, often much elongated, narrow, in fruit often widely ascending or suberect, commonly lobed much as in *Rosa humilis*.

*ROSA CINNAMOMEA L.

Several scattered plants along an old field south of the town, June 12, 1908, just in flower.

ROSA RUBIGINOSA L.

First observed in 1904, a clump over five feet high in an old field north of the town, where it must have been established for many years; fence corner west of the town; two clusters in a field southwest of Millbrook Swamp (1908); a single bush on the county fair grounds (1909).

*ROSA RUGOSA Thunb.

Straying energetically from cultivation and sometimes appearing far from planted grounds. A single plant by the roadside north of the town, first observed in September 1899, had become a conspicuous growth in 1904. Up to that time this rose had not been noticed elsewhere outside of cultivation except in a neglected lot above the "Cliff," where it had long been established and where it has spread extensively in recent years. In 1908 it had sprung up in several places by fence borders in the neighborhood of the town and was observed on the bluff at Siasconset. The following year single clusters were found at Shawkemo and at as remote and desolate a spot as among the sand dunes in the southwestern extremity of the island. An even more remote station was the sandy shore of Tuckernuck, where a fine cluster in full flower was observed on June 17, 1911. In 1910 an isolated patch flowered in a meadow below the "Cliff." First flowers June 1, 1909, June 3, 1911.

The tenacity with which this rose keeps its foothold when once rooted is well shown by a vigorous cluster, which was found in 1907 flowering on the exposed ocean front on the south shore of the island, at the site of the old Surfside hotel. The hotel, I am told, was demolished in 1901 and had been abandoned some years earlier, and this rose remained the sole vestige of the planting that had brightened the wind-swept and barren spot nearly a decade before.

*PYRUS COMMUNIS L.

Occasionally met with in a wild state, sometimes in far out of the way places. Small trees are frequent in pine scrub south and southeast of the town. A single tree, about seven feet high, grows in a wild thicket towards Quidnet, and a small tree similarly isolated was found in Squam. The only wild tree met with, bearing fruit, grows among scattered pines on the commons, perhaps two miles east of the town; on June 14, 1911, it was about nine feet in height and measured eighteen inches around, six inches above the base.

*MALUS MALUS (L.) Britton.

Frequent among the pines along the old south road, where, I was told, it produces an abundance of small fruit; occasional by roadsides and in old fields, often in a dwarfed or straggling condition; Squam; Surfside road; on the bluff at Siasconset; a tree about fifteen feet high in woodland at Beechwood. Still in blossom June 1, 1909.

ARONIA ARBUTIFOLIA (L.) Medic.

Common in low thickets and pond borders as well as in perfectly dry soils, even in pine woodland. Just in bloom May 30, 1909; everywhere in conspicuous blossom June 17, 1911.

*ARONIA ATROPURPUREA Britton.

Common in dry open places as well as in low grounds. Often untypical, indicating an involved relationship with the preceding. First flowers May 30, 1909; some blossoms remaining June 15, 1910.

*ARONIA NIGRA (Willd.) Britton.

Infrequent, boggy spots near Gibbs Pond; Wigwam Pond; west of Sachacha Pond; near Long Pond; Quaise; Siasconset; a solitary

cluster, perfectly typical, in a dry pine grove on the Surfside road. First flowers May 30, 1909. Petals sometimes rose color in drying.

AMELANCHIER CANADENSIS (L.) Medic.

Thickets and banks, mainly on the eastern side of the island; pine barrens east of Hummock Pond, some flowers as late as June 12, 1909. The largest examples, found at Beechwood and in Quaise, were 15–20 inches in circumference and were estimated to be twenty to twenty-five feet in height, their leaves becoming as large as 11 cm. long by 6 cm. wide, many of them deeply cordate. One of the stoutest examples of the species I have ever seen was met with on Tuckernuck, June 17, 1911; although not more than twenty feet tall it measured forty-two inches around near the base, and thirty inches around above the first fork of the trunk.

It was unexpected to find thriving on Nantucket a tree having elsewhere so strong a bent for wooded hillsides and rocky surroundings. Here the absence of such conditions has forced it occasionally into low thickets in association with *Amelanchier oblongifolia;* and, growing with the typical forms, there occur others difficult to assign as between one and the other of these Juneberries. With two so closely related species placed in association, intercrossing might well be expected, and these intermediate forms are perhaps thus to be explained.

*AMELANCHIER OBLONGIFOLIA (T. & G.) Roem.

Common in low thickets. Full racemes of flowers as late as June 3, 1909; other individuals out of bloom and bearing green fruit by May 30. Petals 8–14 mm. long by 2.5–4 mm. wide. The largest tree observed was in a wet thicket in Pocomo and measured twenty-three inches in circumference about a foot above the base.

***Amelanchier nantucketense** sp. nov.

An erect, at length compactly much branched and very leafy shrub 1.5 dm. to 2 m. high, the bark of the younger parts purplish brown becoming dark gray; leaves often crowded, firm, thickened at maturity, dark bluish green on the upper surface with a subglaucous bloom, at length shining, pale beneath, especially at full maturity, those of the woody branches commonly small, often only 2–3 cm. long and 1.5–2 cm. wide, oval or elliptic and abruptly rounded at each end, or broadened above and more or less cuneate

at the base, finely and acutely serrulate or serrate, especially above, often entire towards the base, in vernation densely rufescent or white-tomentulose, especially on the lower surface, early becoming glabrous beneath but long retaining scattered hairs on the upper face; petioles mostly 1–1.5 cm. long, soon glabrous; leaves of the shoots and young branches becoming 5 cm. or more long and broad, many cuneate-obovate and coarsely dentate-serrate, the primary veins with rather broad interspaces; racemes numerous, short, erect, terminating short leafy branchlets 2–5 cm. long, which are erectly disposed along short or elongated erect or ascending branches, the axis and pedicels early glabrous; flowers 6–14, crowded in small spikelike racemes; pedicels firm, somewhat clavate, mostly 1–1.5 cm. long; calyx lobes rather narrow, lanceolate, acute or attenuate, early reflexed; petals very small, narrowly linear or spatulate, frequently involute, 3–4 mm. long, 1 mm. wide distally; fruit small, globose, reddish purple, slightly glaucous, the surface of the ovary glabrous.

Common on Nantucket in low grounds about the borders of swamps, as well as on the dry moorland and in pine barrens. Passing out of bloom towards the end of May, belated flowers sometimes remaining into the second week of June. Young fruit also at the end of May, becoming mature a month later.

Type near Reed Pond, May 30, 1909, in flower and young fruit; young fruit and leaves of young branch June 10, 1908, in the herbarium of the N. Y. Botanical Garden.

Almost the first one of the not readily determinable plants of Nantucket which drew my attention on my earlier visits to the island is the Juneberry here described. This shrub has since been referred by Dr. B. L. Robinson, on the basis of specimens collected on Nantucket by Judge J. R. Churchill, in 1904, to his new var. *micropetala* of *Amelanchier oblongifolia*, the type of which was from "ledges towards the summit of Blue Hill, Milton, Mass." (Rhodora **10**: 33. 12 Mr 1908.) I have not been able to convince myself that the low and small-flowered Juneberry which finds its home on ledges and exposed rocky places is the same as the seemingly very local and coastwise Nantucket shrub. The rock-loving species is the plant described by Dr. N. L. Britton under the name *Amelanchier spicata* (Lam.) Dec. It is common along the crest of the Palisades of the Hudson River, growing on the most exposed ledges, and is found also rooted in the crevices of rocks

on Manhattan Island as well as in similar situations in Connecticut, New Jersey, and Pennsylvania. A number of years ago this plant was made the subject of careful study by Doctor Britton and myself and we could then reach no other conclusion than that it was an unrecognized species. Subsequently Doctor Britton consulted, at Paris, the type of Lamarck's plant and was satisfied that it established the identity of our saxicolous species.

A character of this plant (*A. spicata*), although not of primary import, nevertheless having a suggestive value, is the white woolly exposed surface of the ovary. By this the plant would seem to be allied to *Amelanchier rotundifolia* (Michx.) Roem. [*A. sanguinea* (Pursh) Lindl.], and additional evidence of such relationship is seen in the form taken occasionally by the leaves and in the pronounced close venation which they sometimes develop. *Amelanchier nantucketense*, on the other hand, is undoubtedly in closer relationship with *Amelanchier oblongifolia* and, like that species, has the top of the ovary nearly or quite glabrous. Both are to be found growing together on Nantucket, displaying contrasts of leaf and flower which I do not think have been given undue recognition in the disposition here made of the new plant. A Juneberry collected in a bog at Long Pond, Aug. 12, 1906, growing with this species and with *A. oblongifolia*, appears to be intermediate between them and is quite probably a hybrid.

CRATAEGUS

It appears that, instead of a single species of white thorn, which it has been supposed was the sole representative of its group native on Nantucket, four or quite possibly five native species belong to the island's flora. One of these, *Crataegus pruinosa* (Wendl.) C. Koch, grows also on Tuckernuck Island and on Chappaquiddick Island, Marthas Vineyard; another, *Crataegus chrysocarpa* Ashe, of which only a single shrub was met with on Nantucket, is on Marthas Vineyard rather frequent; still another, *Crataegus Bicknellii* Eggleston, frequent on Nantucket, is not known to occur anywhere else. The comparison is interesting, that of four species collected on Marthas Vineyard two have not been found on Nantucket, one of which, *Crataegus schizophylla* Eggleston, is, so far as we now know, endemic on Marthas Vineyard, paralleling

the case of *Crataegus Bicknellii* of the more eastward island. It should be said that these two endemic thorns are not at all closely related, belonging, indeed, to very different sections of their group.

For the determinations of all the species I am indebted to Mr. W. W. Eggleston, who has kindly examined my entire series of *Crataegus* specimens collected prior to the present year, and supplied the names here employed.

CRATAEGUS CRUS-GALLI L.

Mrs. Owen, in her catalogue, speaking of the cockspur thorn, says "a hedge enclosing a tract of land west of the town, set out by William Henry Gardner about 1830", and adds "no wild plant has yet [1888] been reported on the island." A decade later the status of this thorn on Nantucket had undergone considerable change. It was found in 1899 that low bushes and small trees had established themselves here and there by roadsides and in old fields and thickets, west and southwest of the town, extending as far as Hummock Pond and the western edge of Trot's swamp. The species is, however, spreading very slowly, and more recent years have witnessed little increase in its numbers. The largest of these wild trees grows at the border of Millbrook Swamp and in 1904 was estimated to be over ten feet in height. There is also a colony of trees in the town, at the foot of the "Cliff," and an old tree surrounded by a numerous scattered progeny among the pines on the site of the old O'Connell farm. This tree has a basal girth of thirty-three inches, and from its size would appear to be contemporaneous with the old Gardner trees. The original hedge of over three quarters of a century ago is still in existence, skirting a grassy tract of rather low ground which has come to be known as the thorn lot. The larger of these trees, gray and shaggy with age, must be rather more than twenty feet in height although many of them are scarcely over half that stature; a few are less than a foot in circumference near the base, but some of the trunks are of much greater size, the largest having a basal girth of nearly forty-five inches.

This introduced species comes into bloom about two weeks later than any of the native Nantucket thorns; first flowers June 17, 1908, June 15, 1910, June 16, 1911.

*CRATAEGUS CHRYSOCARPA Ashe.

C. rotundifolia of the manuals.

A single compact bush about eight feet high, formed of several trunks, grows in a roadside thicket close to the boundary between Quaise and Polpis. It was first observed June 9, 1909, then passing out of bloom, most of the corymbs having lost their petals. Close to it a group of the following species was white with freshly opened blossoms. No other individual of this thorn was met with, nor was any other white-anthered species found on Nantucket. This seems to be the earliest flowering of the island's native thorns. Its leaves and flowers are smaller than those of any of the other species.

*CRATAEGUS BICKNELLII Eggleston.

Discovered on Aug. 16, 1906, in Squam near the Quidnet road; a scattered group of treelike shrubs, the tallest about eight feet high. It was subsequently found in dry thickets or adjoining open ground in Shawkemo, Quaise, Polpis, and Squam, altogether at twelve or more separate stations in the northeastern quarter of the island. The largest examples are of the proportions of small trees, having a strong main trunk 12 to 14.5 inches in girth near the base. It flowers profusely, however, at a height of four to six feet while still having the conformation of a shrub. In full blossom June 7, 1908, June 9, 1909, June 10, 1911; first flowers June 4, 1909; red fruit Sept. 17, 1907. Flowering rather later than any other of the island's native thorns and more conspicuous when in full blossom. Flowers spreading 2–3 cm.; leaves more coriaceous and shining than those of any other of the native species and more deeply and acutely lobed; thorns stouter.

*CRATAEGIUS PRUINOSA (Wendl.) C. Koch.

Found in the same parts of the island occupied by *Crataegus Bicknellii* and in similar situations, but rather more widely spread. In only one instance were the two species seen actually together, although in several cases they occupied adjacent thickets. The nearest points to the town, where it was observed, are on the commons less than one and a half miles to the east, and near the shore at Shimmo Creek. On an exposed knoll, it here forms a close low growth among scrub oak and beech plum and was in full blossom

June 2, 1910. Farther east, in a more protected thicket beyond Abram's Point, it reaches a height of ten feet and seems to bloom a few days later; isolated groups occur also in thickets in Quaise, in Shawkemo, at Pocomo Head Pond, where it was passing out of bloom June 12, 1909, and at several localities in Squam. A small colony was also discovered on Tuckernuck, on a visit made to that island on June 17, 1911. Flowers spreading 1.75–2 cm.; the petals sometimes tinged with pink; leaves thinner than in any other of the Nantucket species, the thorns longer and more slender. Well developed green fruit was collected June 26, 1910. A tree growing at the border of Dyleave Swamp was perhaps the largest native thorn tree seen on the island, having a height of perhaps fourteen feet and a spread of six paces.

Specimens from several of the stations show rather well marked differences and may represent more than one species. Mr. Eggleston considers it unsafe to express an opinion on this point until mature fruit is collected. Specimems from the Abram's Point station differ from all the others in having slightly pubescent to loosely villous corymbs.

There is also a form of *Crataegus* on Nantucket that I have collected at three stations, in Shawkemo, Wauwinet, and Squam, which is almost certainly distinct from *Crataegus pruinosa*, having more deeply and acutely lobed leaves of firmer texture, stouter thorns, and rather larger flowers, the number of stamens sometimes less than twenty and even reduced to ten or twelve. All of these are characters that would be derivable from *Crataegus Bicknellii*, and it would seem to be quite possible that this ambiguous thorn is a hybrid of that species and *Crataegus pruinosa*. I do not myself, however, dare venture into the taxonomy of our wild thorns, and up to the moment of going to press have had no opportunity of submitting this case to the expert judgment of Mr. Eggleston.

*CRATAEGUS MACROSPERMA Ashe.

A group of about thirty small trees in a low thicket in Squam, forming a sort of miniature contracted grove, perhaps twelve to fifteen yards in longer extent. The trunks of the larger of these trees are straight and erect and mostly unbranched below, or with the branches ascending, so that it is possible to walk about

among them. There are also a few outlying small shrubs. On June 11, 1909, these trees were in full blossom above, the petals mostly fallen from the corymbs on the lower branches. Flowers 1.5–1.8 cm. in natural spread, the petals drying pinkish; stamens 5–7. More treelike than any other native Nantucket thorn, the largest examples ten to thirteen inches in circumference near the base and twelve to fourteen feet tall. Branches more ascending than in any of the other Nantucket species, the leaves less deeply lobed and on the upper surface more or less roughened with an hispidulous pubescence; corymbs and young fruit villous, the flowers with fewer anthers than any of the other species.

Note.—Mrs. Owen's catalogue includes "*Crataegus tomentosa* L. var. *punctata* Gray." It is scarcely probable that the species intended was any other than some one of those here reported.

PRUNUS SEROTINA Ehrh.

Common; not ordinarily of a greater height than ten or twelve feet and often much lower, in the most favorable situations reaching a height of eighteen to twenty feet. The bark of the trunk is sometimes unusually smooth and pale. In full blossom from before the middle of June until the end of the month.

PRUNUS MARITIMA Wang.

Very common, occurring in all parts of the island, even on Saul's Hills. In full blossom May 30 to June 15, 1909, and some blossoms remaining as late as June 22. Of unusually large size in a thicket near Tristram Coffin's homestead, the largest example about 10 feet tall and 15.5 inches around near the base.

*PRUNUS AVIUM L.

Spontaneous at several stations among young pine trees south and southwest of the town, also in pine scrub about two miles out on the old south road. No trees observed over ten feet in height and some bearing fruit when only three feet high.

*PRUNUS CERASUS L.

Here and there about long-abandoned farms and occasionally in wilder places, as in a thicket in Shawkemo with *Crataegus Bicknellii*, and among pines perhaps a mile southeast of the fair grounds; thicket in Squam.

*AMYGDALUS PERSICA L.

Spontaneous in waste spots about the town and occasionally at more distant points; on the bluff at Siasconset; one small tree on the old south road, about two miles from the town; a single tree about ten feet high at the border of a thicket in Squam.

*PRUNUS AMERICANA Marsh.

A small colony among pines on the road to Surfside, about a mile from the town, some of the trees very young, others about eight feet high; doubtless introduced. Still in blossom June 6, 1909.

Cryptomeric inheritance in Onagra*

C. STUART GAGER

(WITH PLATES 20 AND 21)

In a previous publication[5] I have described an abnormal plant of *Onagra biennis* that appeared in the experimental plot of the New York Botanical Garden in a pedigreed culture following exposure to radium rays. The seed that produced the plant developed in an ovary exposed, before pollination, for 24 hours to the β and γ rays from radium bromid of 10,000 activity contained in a sealed glass tube. After this exposure the stigma was pollinated with unexposed, and, so far as known, normal pollen from another pedigreed individual of *O. biennis*. As described in the paper above cited, the seed gave rise to a plant that produced two shoot systems of equivalent value; that is, neither could be regarded as the main axis of which the other was a lateral branch. Apparently each half of the shoot was from a bud axillary in a cotyledon. Thus it was held that the anomaly was not a bud sport, in the ordinary sense of the word, "unless, keeping in mind that the plumule is a bud, we decide that there was an early bifurcation of the developing embryo, of such a nature that, after the cotyledons were laid down, there was a division of the growing point, accompanied by a separating out of antagonistic characters, and resulting in the formation of two morphologically as well as physiologically different shoots."

Each half of the seedling (*15a* of my cultures) developed in the usual way, forming a rosette in the seed pan, and subsequently, when planted out, sending up a cauline stem from the center of each rosette.

Taxonomic descriptions of the two plants are here repeated from the former paper,† and also an illustration of the young seedling (FIG. 1).

* Brooklyn Botanic Garden: Contributions No. 3.

† Loc. cit. 251.

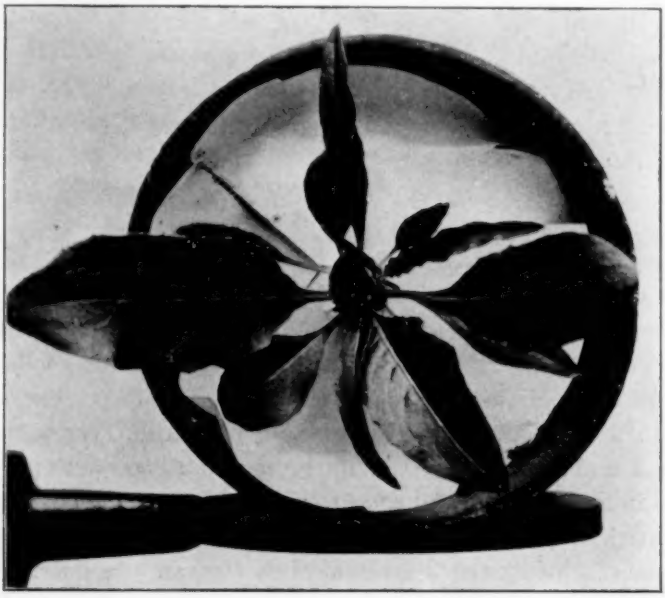

FIG. 1. *Onagra biennis*. Radium culture, no. 15a. Two rosettes, one narrow-leaved and one broad-leaved, on one taproot. Cf. FIG. 2, and PLATES 20 and 21.

15a broad

Rosette leaves finely and sparingly pubescent, the larger ones about 15 cm. long; blades spatulate to elliptic-spatulate, sinuate-dentate especially below the middle, often sharply or prominently so near the base, much longer than the petioles; stem 7 dm. tall, with elongate ascending branches on the lower part; stem leaves mostly spreading; blades narrowly elliptic, somewhat acuminate at the apex, sinuate-dentate; bracts similar to the stem leaves but smaller and usually broadest

15a narrow

Rosette leaves finely and sparingly pubescent, the larger ones 10–12 cm. long; blades almost linear, acuminate at both ends, undulate, somewhat longer than the petioles; stem 6.5 dm. tall, with relatively short ascending branches throughout; stem leaves mostly drooping; blades narrowly linear-lanceolate to almost linear, tapering to both ends, undulate-sinuate; bracts similar to the stem leaves but smaller; hypanthium about 45 mm. long; sepals about 30 mm. long, fully as long as the

below the middle; hypanthium about 35 mm. long; sepals about 25 mm. long, slightly shorter than the free portion of the hypanthium, the free tips in the bud subulate, 2.5–3.5 mm. long; petals about 15 mm. long, nearly truncate at the apex; capsules columnar, slightly narrowed to the apex, about 35 mm. long, much narrower than the bracts.

free portion of the hypanthium, the free tips in the bud long-subulate, 3–4 mm. long; petals about 20 mm. long, nearly truncate at the apex; capsules almost columnar, about 25 mm. long, slightly narrower than the bracts.

FIG. 2. *Onagra biennis*. Radium culture, no. 15a, showing two distinct shoots, morphologically unlike, on one root. The narrow-leaved shoot is at the left. Cf. FIG. 1, and PLATES 20 and 21.

The narrow-leaved branch bore flowers and opening buds for over a week after the broad-leaved branch had ceased to flower, thus pointing to a functional difference. FIGURE 2 shows the mature plant just before anthesis began. The greater vigor of the broad-leaved branch has obscured the equivalency of the two halves, so that the narrow-leaved portion *appears* in FIGURE 2 to be a lateral branch, arising from near the base of the other. Such, however, as pointed out above, was not the case. In PLATES 20 and 21 the morphological features are shown in detail.

Attempts to secure seed from *15a narrow*, either by its own pollen or by crossing it with *15a broad*, were not successful. The broad-leaved branch formed abundant seed when self pollinated, and also when crossed with pollen from *15a narrow*, but in the latter case only one seedling appeared in the seed pan. This plant manifested, throughout, only the characters of *15a broad*, and from it was collected an abundance of close-bred seed, for the purpose of testing whether or not a disjunction of characters would occur. The F_2 generation was grown in the experimental garden of the University of Missouri, at Columbia, Mo. Out of several hundred seedlings, not one showed the characters of the narrow-leaved grandparent, nor did any of these characters appear, either by bud sporting or otherwise, in plants that were allowed to mature.

The following explanations of the original anomaly appear plausible.

1. AN INJURY TO THE ANLAGE OF THE PLUMULE.
2. A QUALITATIVE CHANGE IN EITHER THE EGG OR SPERM that united to form the fertilized egg which gave rise to the plant.
   a. In the egg, due to exposure to the radium rays.
   b. In either egg or sperm, spontaneously, or independent of the radium.
3. SECTIONAL BUD-SPORTING IN THE ANLAGE OF THE PLUMULE.
   a. Due to causes residefit in the cells (i.. e., spontaneous), and irrespective of the radium rays.
      (1) The mutation occurred IN THE ANLAGE OF THE PLUMULE.
      (2) The mutation occurred in one of the germ cells, and the mutated characters first became active as the

plumule developed. This was due either to their separating from the normal characters during nuclear divisions, or to the normal characters becoming inactive.

b. As a result of the previous exposure to radium rays.

Suggestions 1 and 3 (1) above imply, of course, that the anomalous *Onagra* shoot was the expression of merely a somatic change in the plant body, not involving the germ cells at all, and that this is why the atypical characters did not reappear in the generation resulting from a cross between the unlike shoots; or, in other words, that the characters of the narrow-leaved shoot were not represented in the sperm cells of its pollen, and that these gametes were of hereditary content identical with those of the broad-leaved shoot. It is difficult, however, to conceive that such a condition could be realized, since the sperm cells, as truly as all the other cells of the narrow-leaved shoot, are the lineal descendants of the somatic cells which by the supposition were held to have sported. If, however, the characters of the narrow-leaved shoot were due merely to the fact that certain factors that were active in the broad-leaved shoot became inactive in the cell, or group of cells, that give rise to the narrow-leaved shoot, then it is thinkable that these factors became active again in the sperm cells and that thus the original condition was restored. But this does not seem very probable.

A much more probable solution than this emerges from the hypothesis of intracellular pangenesis*: namely, that the change resulting in the narrow-leaved shoot involved only the cytoplasm of the somatic or germ cells concerned, while their nuclei continued to carry, in the inactive state, the original hereditary deposit of the immediate ancestry. Whether the vehicle of this inheritance is conceived of as granular pangens, or as biogens of a definite kind, or as droplets of some enzyme or other chemical substance, or as a relationship merely, between certain bodies, or as any other kind of a "gene," does not affect the hypothesis of a change involving cytoplasm only. In this way an unaltered nuclear germ track might ramify through the plant, resulting in gametes perfectly typical so far as the nucleus is concerned. It is quite probable

* de Vries[16], 197–207.

that we have too much neglected the extra-nuclear cytoplasm in the consideration of the problems of heredity.

Whatever the mechanism of the change is conceived to be, the presumption is in favor of the radium rays as the determining antecedent condition, since such behavior, in the absence of this influence, has never been recorded. But that such a result as the double plant occurred at all is the significant botanical fact; the external "cause" of it is not so important.* Any explanation necessitates the formulation of some definite conception of the structure of protoplasm, and the mechanism of inheritance, and involves the consideration of several working hypotheses already elaborated.

Perhaps the most formal of these hypotheses is that of intracellular pangenesis. The essence of this now familiar hypothesis is that all living protoplasm consists entirely of pangens. Pangens are not chemical molecules, but masses of a higher order, having the power of nutrition and growth, of multiplication by division, and of becoming active or latent according to circumstances. When latent they are usually in the nucleus, and become active only when they pass out of the nucleus into the cytoplasm of the cell. These pangens are the bearers of the inheritable unit characters. A change in only the number of pangens causes fluctuating variations; the loss of one or more, or the formation of one or more new kinds of pangens underlies (*is*, in fact) mutation.† As de Vries[17] has stated, this conception formed the basis of the experiments described in his *Mutationstheorie*.

The bearing of this hypothesis on the double primrose-plant is almost too obvious to need stating. We may conceive that all the unit characters which found expression in both the broad-leaved and the narrow-leaved shoot were originally represented in either the egg nucleus or the sperm nucleus‡ that fused in the fertilization. As the fertilized egg developed, they were passed on by nuclear and cell division to all the cells of the embryo; and the apical meristem, at the time the plumule began to be laid down,

* Save as suggesting the possibility of artificially inducing mutative variations by means of radium rays.

† This protoplasmic change is called by de Vries "premutation".

‡ Or both, according to which one of the circumstances above suggested is regarded as the initiation of the change.

became differentiated into two unlike portions. In the cells of one half, the pangens fundamental to the distinguishing characters of the narrow-leaved branch became active, and the pangens fundamental to the distinguishing characters of the broad-leaved branch became latent or wanting. In the cells of the other half the reverse conditions obtained.

From the very nature of the hypothesis of intracellular pangenesis, this is, of course, a very formal explanation.

In chapter XIX of my memoir[5] on Effects of the Rays of Radium on Plants, I have suggested that the effects of the rays may be due to their influence, not directly on the living matter itself, but indirectly, on the enzymes or other non-living inclusions of the cells. This idea of the possible rôle of enzymes in morphogenic changes has been more elaborately worked out by Spillman,[12] who rejects the notion of a supermolecular, organic pangen in favor of, for example, an enzyme acting on some other chemical body, such as a chromogen. "All known Mendelian phenomena," says Spillman,* "may be explained as due to differences in the chemical constitution of the chromosomes in different groups." The failure of a character to appear is attributed to "the failure of a single chromosome to perform a particular function." A practically identical hypothesis was suggested independently by Holmes.[17]

Additional evidence that enzymatic action may be involved in mutation is found in the inference, made by de Vries[16] (p. 264), that mutating seeds remain viable longer than non-mutating ones; for it is well known that profound enzymatic changes occur in the aging of dry, resting seeds. Albo's[1, 2] investigations indicate that the energy for the changes undergone by such seeds is enzymatic in origin, and he states that he was able to demonstrate that diastatic activity was either diminished or entirely wanting in seeds that had lost their capacity to germinate. Dry seeds of many families, and able to germinate, were found by Brocq-Rousseu and Gain[3] to contain a peroxydiastase, which the writers claim was never present in seeds that had lost the capacity to germinate. Miss White,[18] however, reports tests on the resting seeds of cereals, showing the presence in them of diastatic, ereptic, and fibrin-digesting enzymes, still active after a period of over

* Loc. cit. 246.

twenty years and after the germinating power of the seeds had been lost. According to Albo, the diastatic power is gradually lost, and it is not at all improbable that the decomposition products, resulting from the breaking down of some enzyme (or other substance, for that matter), may alter the hereditary content of the nucleus, in a manner similar to that effected by MacDougal[9,10] by injecting dilute solutions of various substances. This would offer a simple explanation of de Vries's observation, above referred to, that older seeds give a larger percentage of mutation than fresh ones. The accumulation of these disintegration products in the nucleus might inhibit or retard the action of certain enzymes involved in growth and development. Moore[11] has already suggested that our methods have heretofore been inadequate in taking account of only the end products of reactions. On the other hand, it is possible that new enzymes may develop and become the active agents in the alteration of the nucleoplasm.

In discussing the manner of origin of an *O. rubricalyx* mutant from an *O. rubrinervis* germ cell, Gates[6] (loc. cit. 204) dismissed de Vries's conception of pangens as "too formal an assumption to be accorded the dignity of an explanation," yet later on (ibid. p. 209) he speaks of "a fundamental change in the germ-plasm," without suggesting how we are to picture this "fundamental change." The rejected theory of de Vries is that of a fundamental change, only the fundament involved is clearly conceived and named by its author. It is difficult to understand how pangens are more "formal" than molecules, and it does not seem to the writer that the "formality" of the hypothesis is a priori a valid reason for rejecting it. It is merely a question of, first, does it agree with known facts, and, second, is there any actual evidence that such bodies as pangens really exist? The recent work of Strasburger[15] seems to indicate that there is, and the facts of development and heredity are such as would follow on the basis of pangenesis.

I do not wish to appear as arguing in favor of intracellular pangenesis as an expression of ascertained truth. On the contrary, I am rather inclined to think that it will have to be either rejected or profoundly modified when the truth is known, if it shall ever be known; but rejected, not because it is formal, but for lack of agreement with observed facts.

Lillie[8] has recently held that all hypotheses involving the existence of determinants or character units have served their time, and, referring to the work of Guyer and Montgomery, has emphasized the fact that germ-cell elements (chromosomes) may be segregated in nuclear and cell division. This, of course, is well known, and experiments on the effects of radium rays on nuclear division have shown that normal segregation may be greatly altered, and that even elimination of chromatin may be artificially induced in this way.*

I conceive it as quite probable that in the primordium of the epicotyl of the double primrose-plant such a segregation of chromatin material (possibly not entire chromosomes) occurred, accompanying or inducing the organization of two growing points, each the primordium of an epicotyl, and possessing an unlike relation between the hereditary elements of the cells. Not, necessarily, an unlike hereditary composition, for the characters unfolded in the F_1 and F_2 generations showed clearly enough that the characters of an organism that actually appear are a function—not alone of the inheritance of the cells, but of a relation that obtains between various inheritances, some being dominant, others recessive. The work of de Vries has clearly demonstrated that "hereditary potentialities" which exclude each other in the active state, may occur together when one or both are latent.

A qualitatively different chromatin content in the cells of the two growing points may have been the cause of the development of certain enzymes normally absent, or the repression of other ferments ordinarily present. Or these chromatin differences may have given some ferment a suitable body to act on in the one case and not in the other. Since such things as enzymes and fermentable substances are known to exist in plant cells it does indeed seem unnecessary to call in the assistance of an imaginary, new kind of body, until the ones already actually experienced have been shown to be inadequate.

Certain it is, however, as the rich mass of illustrations brought together by Darwin and by de Vries has previously emphasized, that the inheritance of a character and its expression are two entirely different things. The appearance of the double *Onagra*,

* Gager[8], Chapt. XVII.

and the character of its first and second filial generations, constitute a striking case in point.

BROOKLYN BOTANIC GARDEN.

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Explanation of plates 20 and 21

PLATE 20

Onagra biennis. Radium culture, no. 15a, broad leaf. The stigma was pollinated with pollen unexposed to radium rays after the ovary had been exposed for 24 hours to rays from radium bromid of 10,000 activity in a sealed glass tube.

FIG. *a*, flower bud, with bract, taken from a lateral branch; *b*, petal; *c*, nearly mature capsule, with bract (main stem); *d*, flower (minus corolla); *e*, leaf from main stem. Cf. PLATE 21, and FIG. 1 and 2.

PLATE 21

Onagra biennis. Radium culture, no. 15a, narrow leaf. For exposure to radium rays see legend of PLATE 20.

Induced and occasional parasitism

D. T. MacDougal

(WITH PLATES 22–25)

The results of some experiments in which regenerated cuttings of several succulent seed plants were made to become xenoparasites on various hosts have been published by the author during the last two years.*

Regenerated cuttings of vines and of cacti were inserted in cavities prepared for them in the bodies of other plants used as hosts, being held in place by plaster of Paris seals, and the course of growth followed for extended periods. A consideration of the morphological and chemical features of the parasite and host of all such nutritive couples was then made, to ascertain what factors made it possible for one plant to become dependent or parasitic on another. It was notable that outside of the single anatomical feature of the possession of a water balance or accumulated supply of fluid, no morphological characters might be taken as indispensable in possible parasitism. It might be seen, however, without recourse to experimental results, that certain habits of growth, of rapid formation of wound tissue and of excretions might well prevent a plant from being fastened upon by a parasite. The chemical examinations showed that when one form was induced to become parasitic upon another, the host in every case had a sap with a lower osmotic activity than that of the xenoparasite. At the same time a cutting of a species with high osmotic pressure might fail to establish itself on another plant of lower activity. This was especially true of the sahuaro, or great tree cactus (*Carnegiea*). Its succulent stems, with soft subepidermal structures, offered most inviting conditions to the experimentalist, but the acrid secretions poured into wounded cavities generally prevented inserted cuttings from withdrawing solutions that might serve as

* See The condition of parasitism in plants. Carnegie Inst. of Washington. Pub. No. 129. 1910; The making of parasites. Plant World **13**: 207. 1910; and An attempted analysis of parasitism. Bot. Gaz. **52**: —. 1911. (In press.)

nutriment. The sole survivors on this plant as host are two opuntias, one a cylindrical and the other a flattened form, while the failures may be numbered by the score.

Opuntias with mucilaginous juices also offered unfavorable conditions for parasites. While this work was being done, estimates of the acidity of the sap of various cacti were made of specimens taken at random without regard to the time of day, exposure to light, or temperature. No connection could be established between acidity and parasitism with such data at hand. Recently, however, Prof. H. M. Richards has carried out some work on respiration at the Desert Laboratory, in which it was found that the acidity of a cactus is four times as great at sunrise as late in the afternoon, and that the amount of acid present is affected in an important manner by the rise and fall of the temperature. These variations together with the effect of the changing acidity upon the absorptive capacity of the mucilages and of other colloids, such as those of the cell walls, might account for the entire lot of experimental cases presented. Indeed, it is not too much to say that when all of these factors are properly integrated, the possibility of dependent parasitism between two species might be predicted with fair certainty.

After the completion of the last article dealing with this subject a few of the experimental parasites still remained active. The description of the further history of these arrangements and of some unusual conditions of this kind found among native plants constitute the purpose of the present paper.

A case of parasitism of *Opuntia Blakeana* on *Carnegiea gigantea* was discovered in Roble's pass, 7 miles southwest of the Desert Laboratory, on March 19, 1911, and a visit was made to it a few days later in company with Prof. H. M. Richards for the purpose of making a detailed examination and photographs.

The sahuaro was a tall specimen with four branches, being about two hundred years old. The largest branch was about 12 feet long and arose from the trunk about 7 feet from the ground. Germination of an *Opuntia* seed had evidently taken place in the axil, and the roots had penetrated the corky layers in the angle. The growth of the opuntia had resulted in the development of two main stems, one consisting of two and the other of three joints,

which showed some atrophy. The season of 1910 had been very dry and a small cylindrical branch had arisen from the basal cylindrical part of the stem, the terminal section of which had died back. (See PLATE 22.)

The large branch, which was over a foot in diameter at its base, was cut away and the roots of the opuntia dissected out, a task of some difficulty. Some of the rootlets reached a distance of a foot from the base of the opuntia, and while many of the branches partly encircled the base of the branch of the sahuaro, yet one main root and its branches had penetrated directly inward into the tissues of the greater cactus to a depth of over six inches, being completely submerged and cut off from the air. The advance of the root had been followed by the death of the cortical cells of the host and by the formation of scar tissue enclosing the parasitic roots, and then secondary root formation had followed, which resulted in a dense mesh of fibrils, none of which were in actual contact with living tissue. (See PLATE 23.)

The contact thus made with the *Carnegiea* was undoubtedly the source from which the chief supply of solutions was obtained. The remainder of the root systems was in such position that the moisture collected in the sinus of the branch and the stem might be absorbed, but as the amount of this liquid would be small and would be available for only a few hours during the entire year, it is all but a negligible quantity in the nutrition of the opuntia. A transverse section of a portion of the cortex enclosing a penetrating root would show this organ surrounded by a flattened tube of corky tissue derived from the cortex of the host. The folds of this tube extended for several millimeters from the root.

The parasitic opuntia was brought away intact and set in the soil in the terrace of the Desert Laboratory to allow observation of its further development, and under autophytic conditions. Similar experience with a plant taken from a *Parkinsonia* showed an abrupt alteration in the amount, rate of growth, and form of the flattened stems. [Bot. Gaz. **52**: —. 1911. (In press.)] So great was the difference that the identity of the species was mistaken previous to its cultivation in the ground under the customary conditions.

An *Opuntia discata* growing from the trunk of *Acacia* was reported by Dr. W. A. Cannon in 1909 and a special excursion was

made to examine the arrangement in April 1911. The original photograph, from which a drawing has been made, showed a heavy basal stem of the opuntia issuing from a knot hole in the trunk of the tree and bearing two branches, one consisting of one joint and the other of three. (Plate 24.) The size of the stem of the opuntia would indicate that it was perhaps fifteen or twenty years old, but the limited supply of food material to be obtained from the host had operated to the loss of other flat joints that may have been formed from time to time. The more recent observation showed a main horizontal stem of four joints, from which were arising a number of new joints. A basal branch of three joints was dead and was all but detached from the plant. A single upright joint bore a small young joint rapidly enlarging. Another upright joint and the two terminal joints of the horizontal stem were in a dying condition. It seems probable that the plant yearly gives rise to more branches than may be maintained by the supply of solution derived from the host and that the arid after-summer of 1911 will be the occasion for the death of some of the joints that are being formed in the growing season of the earlier part of the year. (Plate 25.)

It was not deemed advisable to dissect this arrangement until further observations had been made, but it is probable that the development of the roots of the opuntia follow the formation of a cavity in the trunk of the acacia by the decay of the wood, and that the roots of the intruding cactus operate to cause or hasten this integration. A similar case of *Opuntia* on *Parkinsonia* has been previously described. (See Publication 129, Carnegie Inst. Washington, 1910.)

A plant of *Opuntia Blakeana* set in the side of a trunk of *Carnegiea* early in 1909 has continued a fairly even existence although no growth in the way of formation of new joints has been seen. The plant consisted of a basal cylindrical section and a terminal oval joint. The plaster, which was used to hold the xenoparasite in place when first arranged, has gradually crumbled away, but the parasite is held firmly in place by its own roots. As has been previously noted, some thickening of the basal portion of the stem is noticeable. The amount of growth to be expected from parasites is always less than that of autophytic individuals.

That some actual parasitism or derivation of nutriment takes place, is evident from the fact that similar small plants separated from the soil and exposed to the same climate desiccate within a single season, while this preparation has survived three hot summers. A small individual of *O. versicolor* set in the trunk of a *Carnegiea* in the spring of 1909 is also robust and thriving, having undergone considerable thickening of the stem, one branch, and the exposed portion of the roots. Both of the above preparations give every appearance of being permanent during the ordinary life cycle of the individuals.

Some of the most important experimental results were obtained by using regenerated cuttings of a grape (*Cissus laciniata*), from the region of Tehuacán, Mexico, as a parasite, and some new arrangements were set up early in 1911. This plant undergoes secondary thickenings of the stems in such manner that portions near the ground, or partially imbedded in it, attain a diameter of several inches, and contain large balances of water and food material. Oftentimes the thickening will take place in portions of the climbing stem many feet from the ground. The thinner portions of the stem die upon the cessation of active growth, with the consequence that sections of thickened stem may be supported by the dead tendrils high above the substratum. In some instances such thickened sections will be held by a second vine, clasped by the tendrils. The beginning of activity in these suspended stems usually consists in the formation of long adventitious roots which hang down and are capable of making a length of one or two yards. If the ground is reached, new supplies ascend through the aerial roots and the plant survives. Many of the thickened sections are held at such elevation that the supply of water and material does not suffice for the construction of roots of a length that may reach the ground, and consequently the isolated members perish. Similar behavior was exhibited by plants in the glass house at the Desert Laboratory. It is evident that such suspended sections offer some chance of contact or penetration of other living plants, thus setting up parasitism, and the previous experiments showed that this grape might be made parasitic on *Opuntia*, *Echinocactus*, and sometimes on *Carnegiea*.

A number of new preparations were made in April, 1911, in

which cuttings were inserted in resting potato tubers and also in joints of *Opuntia Blakeana*. Late in May it was found that nearly all of the cuttings in potatoes were forming short basal roots with still shorter clubshaped branches, and the cavities about them were being enlarged rapidly by decay. A few cuttings were sending out aerial roots from the upper ends. These were all transferred to joints of *Opuntia*, some in the glass houses and some in the open, late in May, 1911. All in the glass house were alive, and about half of those in the open, in August, 1911. The amount of leaf development was small and the growth of the shoots offered no features not previously described.

It is notable that in these, as well as in all previous experiments dealing with this subject, very little evidence of forcible penetration of the tissues of the host was seen. Whether by the previous action of bacteria or by excretions from the xenoparasite, the invading roots never actually bored through masses of living cells. In all cases the layer of tissue, one or more cells in thickness, nearest the roots was found to be dead and more or less disintegrated. Peirce, in his earlier work on this subject, cites instances in which roots of *Brassica* and *Sinapis* actually penetrated among living cells by a comparatively rapid growth. (Das Eindringen von Wurzeln in lebendige Gewebe. Bot. Zeit. **52**[1]: 169. 1894.)

It is notable that the experiments included in this research, which has been carried on for four years, were made under extremely arid conditions, in which the transpiratory loss was high. The plants that were induced to live as parasites were therefore under the double burden of securing nutriment from a host, which furnished a substratum offering physical conditions widely different from those which their absorbing organs ordinarily encounter, and of maintaining their own turgidity as a necessary condition of growth and other constructive processes. As has been amply demonstrated, the change from an autophytic to a parasitic condition is one that may be readily made by many species. The distributional movements of plants, which are constantly bringing new pairs into contact, would operate to bring eligible parasites and possible hosts together and cases of newly originated dependent nutrition may be expected from time to time.

The instances reported in this and previous papers are of this character. The instances cited were found by the examination of a small number of species. A comprehensive survey of the root habits of any region would doubtless reveal a large number of parasitic arrangements of various kinds as yet unknown to us. The recent discovery of the parasitism of *Krameria* by Dr. Cannon was made by the use of such methods, and has added a tenth to the list of families with parasitic members.

DESERT BOTANICAL LABORATORY,
TUCSON, ARIZ.

Explanation of plates 22-25

PLATE 22. *Opuntia* in the angle of branch and stem of sahuaro. Drawn from a photograph.

PLATE 23. Detail of roots of *Opuntia* parasitic on sahuaro. (See PLATE 22.) Drawn from a photograph.

PLATE 24. *Opuntia* on *Acacia*. Drawn from a photograph made in 1909 by Dr. W. A. Cannon.

PLATE 25. *Opuntia* on *Acacia* in 1911. Photograph by the author.

A new variety of Carex lupulina

EARL E. SHERFF

(WITH PLATE 26)

In the summer of 1909, the writer's attention was attracted by some peculiar sedges growing in a small stretch of swamp east of Thread Lake, at Flint, Michigan. In most respects they resembled *Carex lupulina* Muhl., but differed from the species proper in having white-margined leaves (including bracts) and scales and white-striped perigynia. Muhlenberg,* in his original description of *Carex lupulina*, makes no mention of this form.

At first a pathological cause was suspected of producing the peculiar color design. Typical *Carex lupulina* growing interspersed with the form was studied, and in no case was the color found to vary toward that of the form. Likewise, a study of many specimens of the form failed to show an intermediate stage between its color and that of the species. And further, where the stolons of both crossed and intertwined with each other, it was found that plants from any individual stolon or system of stolons were uniformly either all of the form or all of the species proper. In other words, the two were sharply distinct. Had the cause been pathological, it is not improbable that cases would have occurred in which the cause was but weakly operative and the demarcation hence less distinct. Especially would an intermediate stage be expected in the young plants vegetatively produced by stolons and established some distance from the parent plants. Such intermediate stages being absent, it thus appears certain that we have to deal with a definite, fixed form and not with a temporary form induced by some obscure pathological factor.

Unfortunately, material had scarcely been gathered for specimens when the level of Thread Lake was raised several feet by the reconstruction of the dam at its outlet, extending the lake back over and flooding the area occupied by the sedges. This

* Mühlenberg ex Willd. Sp. Pl. 4: 266. 1805; Schkuhr, Riedgr. 2: 54. *t. Ddd. f. 123 & t. Jiii. f. 194.* 1806.

has made it impossible to secure more material for experimental work with achenes and stolons, as all of the sedges were destroyed. The original specimens have been deposited with the herbarium of the Missouri Botanical Garden (type), the Gray Herbarium, and the herbarium of the Field Museum.

The new plant is here introduced as a formal variety and given the name

Carex lupulina albomarginata var. nov.

Carex formae typicae dissimilis, foliis et squamis albomarginatis, perigyniis albolineatis.

To Dr. Wm. Trelease of the Missouri Botanical Garden and to Dr. J. M. Greenman of the Field Museum the writer's sincere thanks are due for a critical examination of material, also to Professor C. E. Barr of Albion College for the careful execution of the accompanying plate of illustrations.

CHICAGO, ILL.

Explanation of plate 26

A, upper portion of mature plant; B, lower portion; C, portion of leaf; D, perigynium; E, achene; F, pistillate scale; G, staminate scale.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1910–1911)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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